Digital Speech Processing
HW2-1 report

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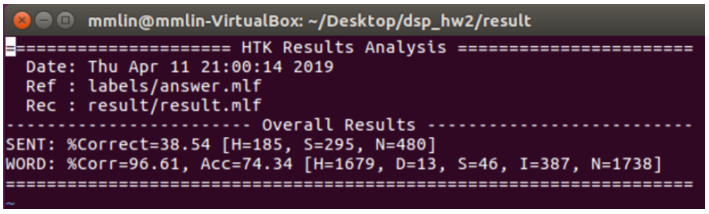
1 Run Baseline

After running the shell scripts provided by TA in the directory of hw2-1,

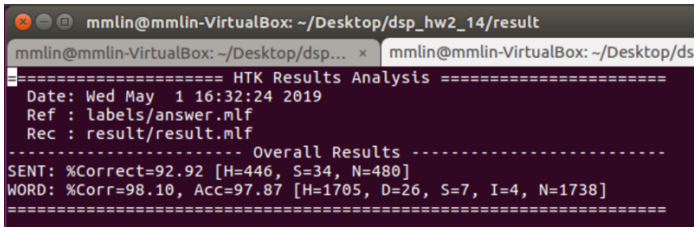
```
bash 00_clean_all.sh
bash 01_run_HCopy.sh
bash 02_run_HCompV.sh
bash 03_training.sh
bash 04_testing.sh
```

the baseline result of 74.34% accuracy is shown in the result/accuracy file.



2 Improve Accuracy

The following screenshot shows that the best result after adjusting various parameters is 97.87% accuracy.



3 Discussion

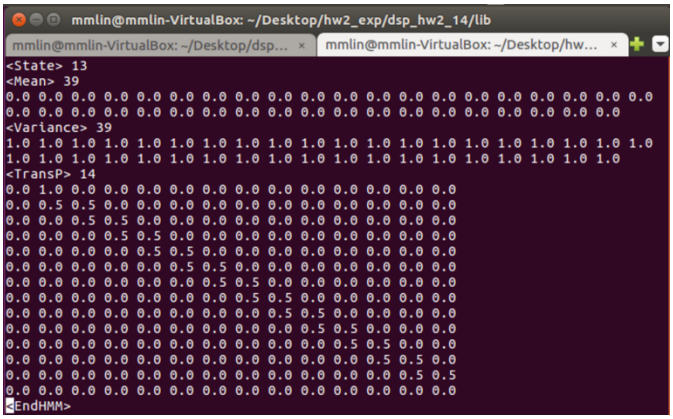
1. The training of the best result
    a. Execution

    Run the following commands in the directory of hw2-1.

    ```
    bash 00_clean_all.sh
    bash 01_run_HCopy.sh
    bash 02_run_HCompV.sh
    bash 03_training.sh
    bash 04_testing.sh
    ```

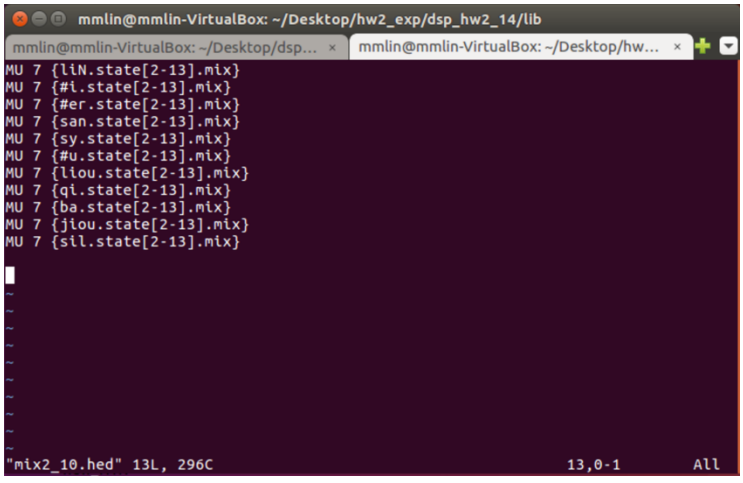
b. lib/proto

I set the number of states of HMM to 14 and the transition probability matrix as the screenshot shows.



c. lib/mix2_10.hed

I increased the number of Gaussian mixtures to 7 and changed the mixture number from state 2 to state 13.



d. 03_training.sh

In the training process, I increased the number of iterations as the following to increase accuracy. Since $P(\bar{O}|\lambda)$ in HMM can improve more after more iterations, increasing the number of iterations can achieve better result.

```
################################################
# re-adjust mean, var
echo "step 01 [HErest]: adjust mean, var..."
for i in {0..25}
do
        echo "iteration $i"
        HERest -C $config -I $label \
                -t 250.0 150.0 1000.0 -S $data_list \
                -H $macro -H $model -M $mmf_dir $model_list
done
```

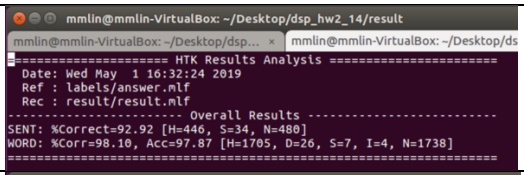
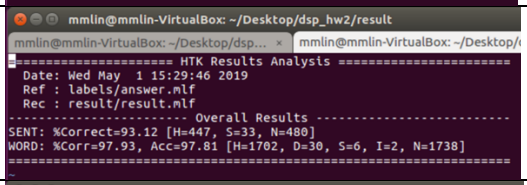
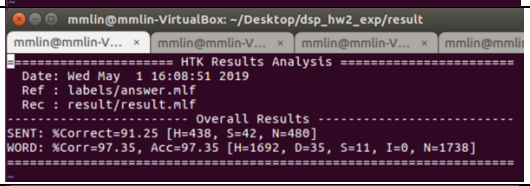
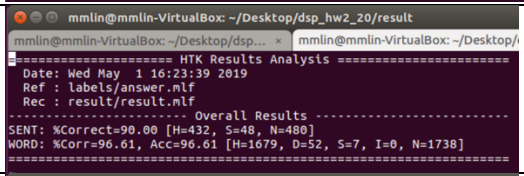
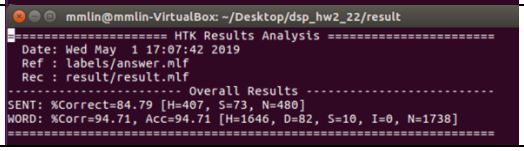
```
# re-adjust mean, var
echo "step 03 [HErest]: adjust mean, var..."
for i in {0..25}
do
        echo "iteration $i"
        HERest -C $config -I $label \
                -t 250.0 150.0 1000.0 -S $data_list \
                -H $macro -H $model -M $mmf_dir $model_list
done
```

```
# re-adjust mean, var
echo "step 05 [HERest]: adjust mean, var..."
for i in {0..20}
do
        HERest -C $config -I $label \
                -t 250.0 150.0 1000.0 -S $data_list \
                -H $macro -H $model -M $mmf_dir $model_list
done
```

2. Experiments

a. Number of states in HMM

After trying different number of states in HMM while fixing other model parameters, I found that "14" can achieve best accuracy. However, when I increased the number of states to 22 and adjusted to change Gaussian mixture number from state 2 to state 21 in lib/mix2_10.hed, the accuracy decreased. The reason might be that too many states can cause over-fitting and thus decrease the accuracy.

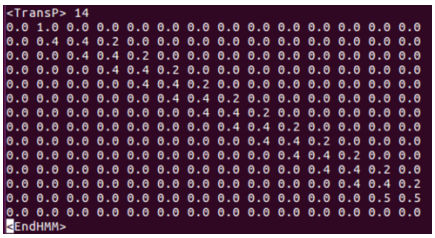
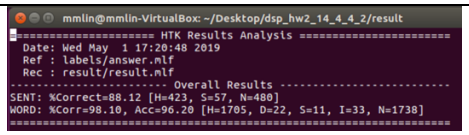
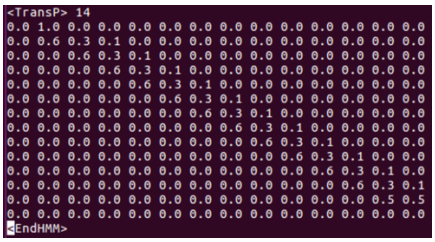
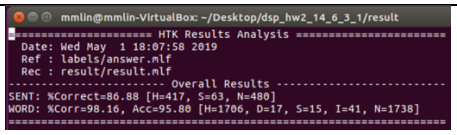
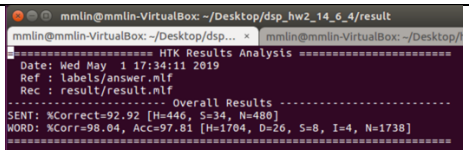
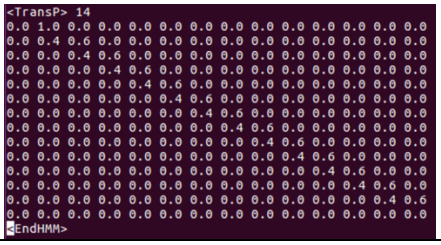
number of states of HMM	accuracy	result/accuracy
14	97.87%	
16	97.81%	
18	97.35%	
20	96.61%	
22	94.71%	

b. Transition probability matrix

I adjusted the values in the initialization of transition probability matrix in HMM in lib/proto to see the differences. It turned out that the initialization of transition probability matrix C and D gave better results than A and B. This result

shows that the HMM states of the data in this assignment tend to jump within two states instead of three states.

Furthermore, the initialization of transition probability matrix of the best result (97.87% accuracy) seems to be the most appropriate initialization of transition probability matrix for the data in this assignment.

transition probability matrix	accuracy	result/accuracy
A 	96.20%	
B 	95.80%	
C 	97.81%	
D 	97.81%